

Model Sensitivity to Emissivity

Emissivity reduces outgoing longwave radiation:

$$\begin{aligned} F_{LWUP} &= -\epsilon \sigma T_s^4 \\ 0 \leq \epsilon &\leq 1 \end{aligned}$$

Background

Emissivity

CICE

CESM

Appendix

Boulder, Colorado.
February 2015.

Matthew S. expresses shock that $\epsilon = 0.95$ in models.
“A better value is 0.985!”

Quiz

Emissivity

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CESM

Appendix

Barrow, Alaska.
April 2015.

If ϵ is changed from 0.95 to 0.985 in a climate model,
does the sea ice get thinner or thicker?

Why?

Sea Ice Model Sensitivity

Emissivity

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Appendix

Los Alamos, New Mexico.
March 2015.

Jorge Urrego-Blanco tests ϵ in CICE sensitivity studies.

ϵ almost (but not quite) tops the list of parameters to which sea ice area and volume are sensitive, in both hemispheres, year-round, in CICE.

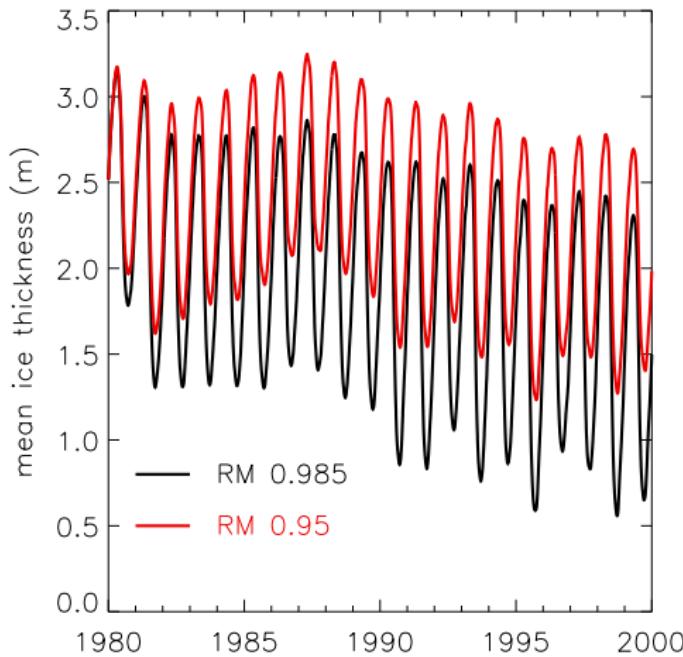
CICE Response

Emissivity

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CICE Response

at the end of 5 years

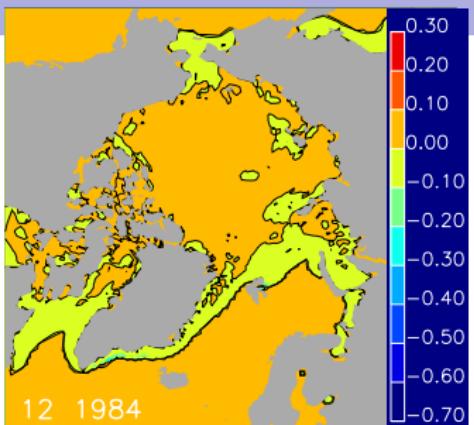
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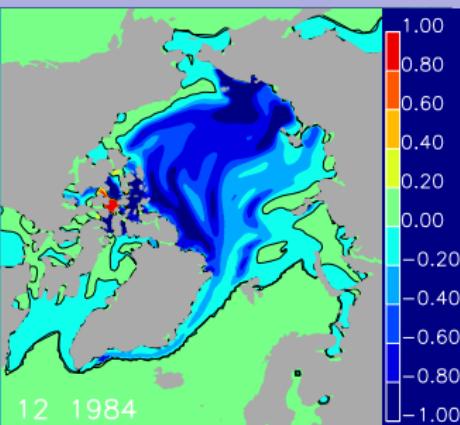
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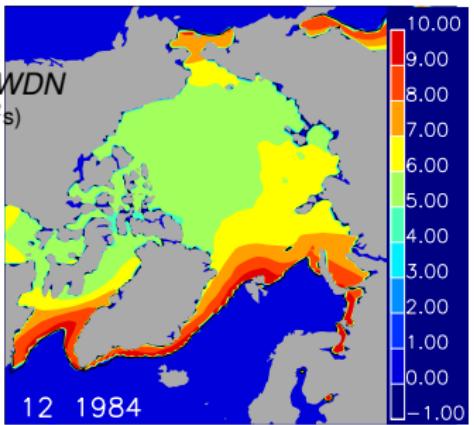
Δa_i



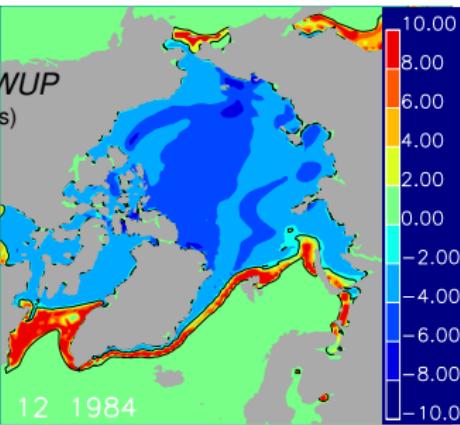
Δh_i
(m)



ΔF_{LWDN}
(W/m²s)



ΔF_{LWUP}
(W/m²s)



Simple Model Response

Emissivity

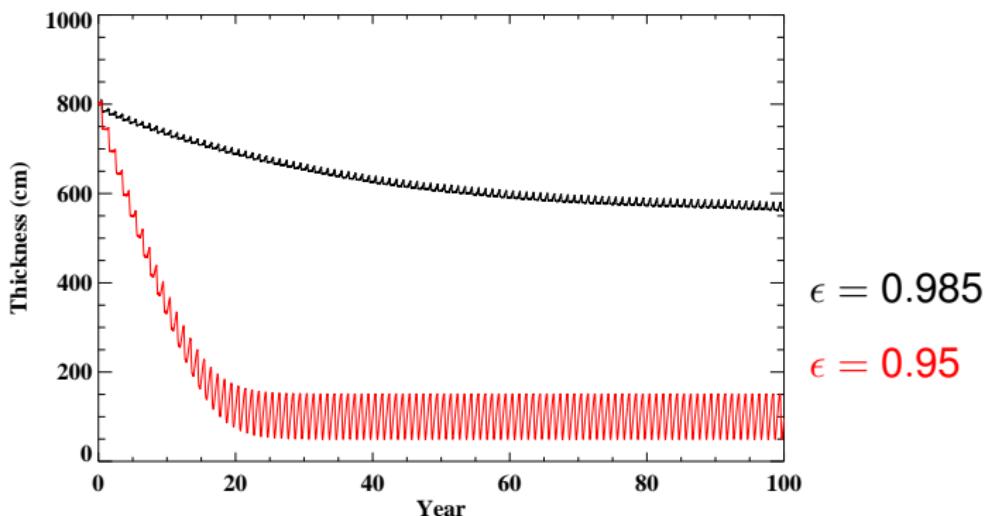
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Appendix

Boulder, Colorado.
March 2015.

Marika tests ϵ in a thermo-only model.



CICE Downward Longwave Forcing

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Standard CICE forcing:

Rosati and Miyakoda, J. Phys. Oceanogr. 1988

$$F_{LWDN} = \epsilon \sigma T_s^4 - F_{netLW}(\epsilon, T_a, f_{cl}, Q_a, T_s)$$

where

$$T_s = a_i T_i + (1 - a_i) T_w$$

Alternative CICE forcing:

Parkinson and Washington, J. Geophys. Res. 1979

$$F_{LWDN} = F(T_a, f_{cl})$$

CICE Response using Parkinson & Washington F_{LWDN}

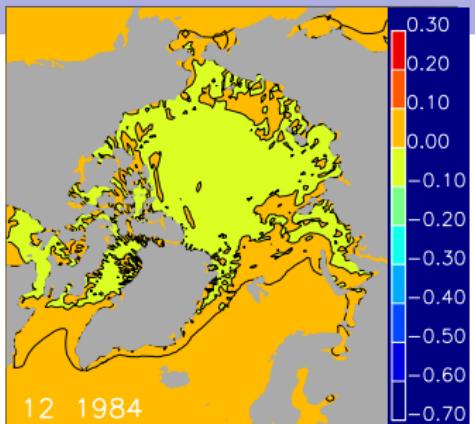
Emissivity

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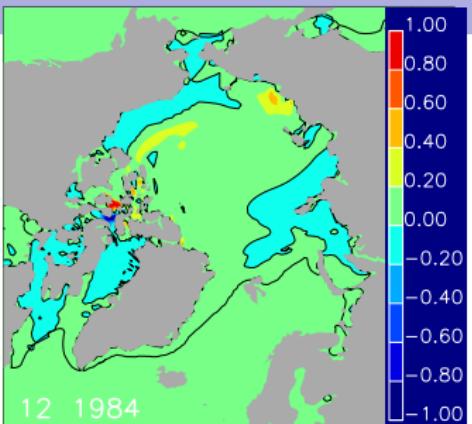
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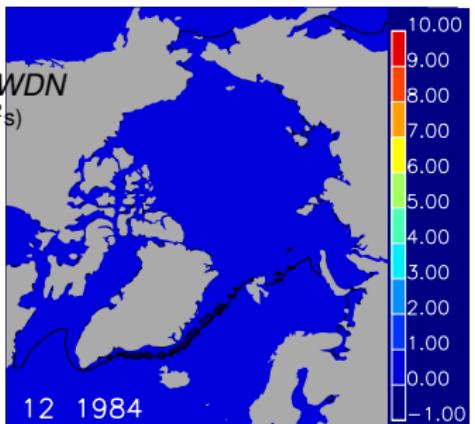
Δa_i



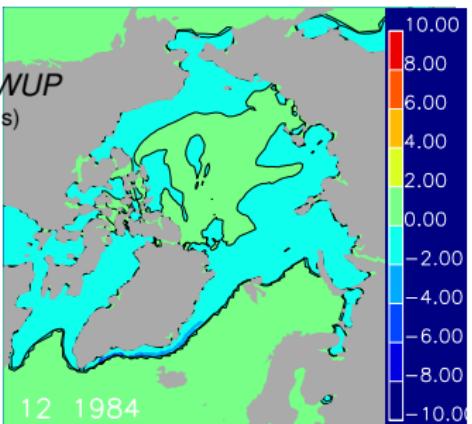
Δh_i
(m)



ΔF_{LWDN}
(W/m²s)



ΔF_{LWUP}
(W/m²s)



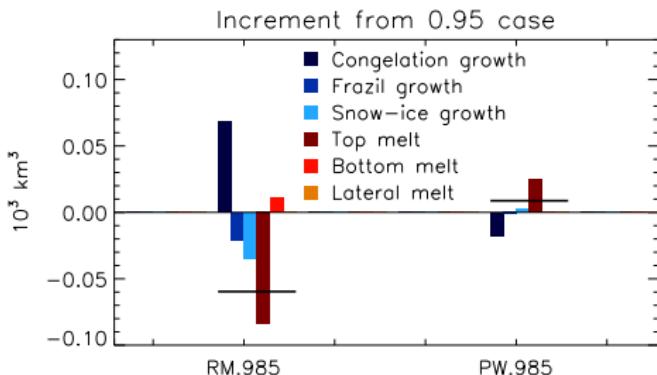
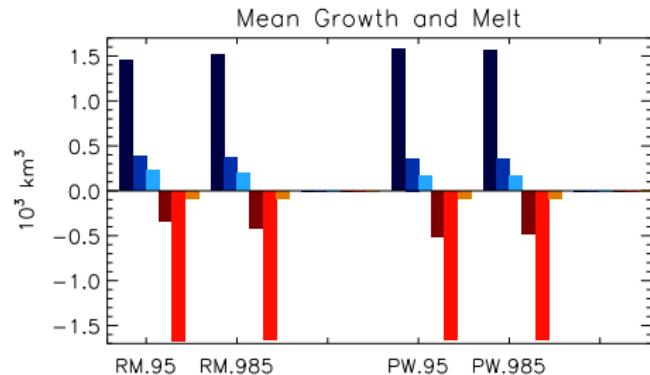
CICE Response

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CESM Response

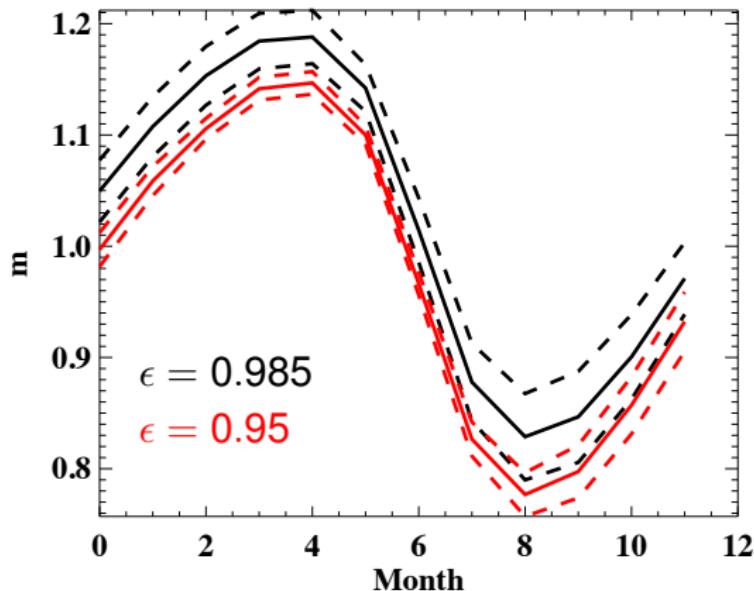
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Boulder, Colorado.
April 2015.



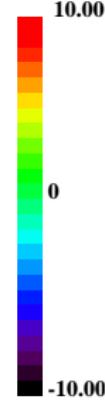
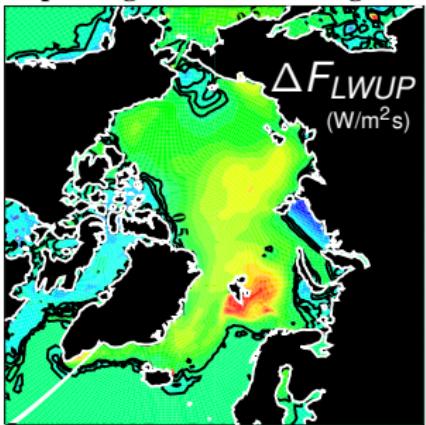
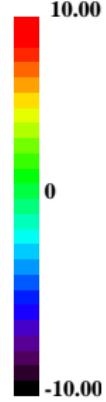
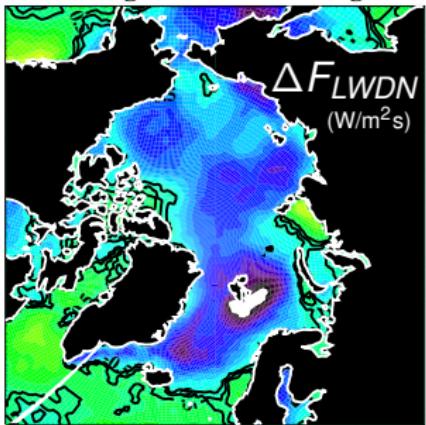
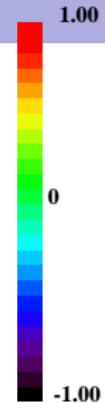
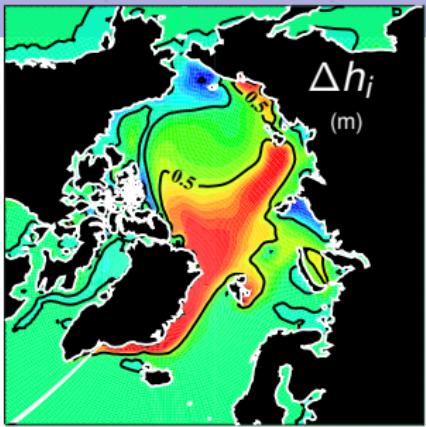
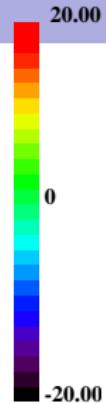
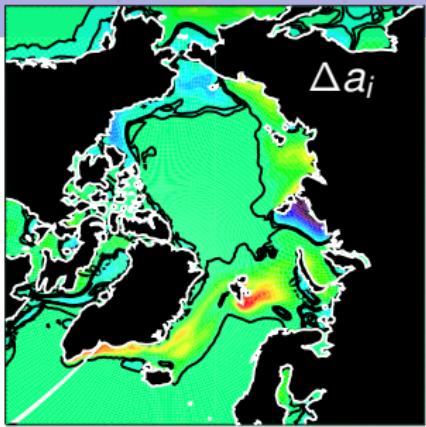
CESM Response

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Take-Home Message

Emissivity

Feedbacks matter.
Are model feedbacks right?

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Standard CICE forcing:

Rosati and Miyakoda, J. Phys. Oceanogr. 1988

$$F_{LWDN} = \epsilon\sigma T_s^4 - \epsilon\sigma T_a^4(0.39 - 0.05\sqrt{e_a})(1 - 0.8f_{clu}) - 4\epsilon\sigma T_a^3(T_s - T_a)$$

where

$$T_s = a_i T_i + (1 - a_i) T_w$$

Alternative CICE forcing:

Parkinson and Washington, J. Geophys. Res. 1979

$$F_{LWDN} = \sigma T_a^4(1 - 0.261 e^{-7.77 \times 10^{-4} (T_f - T_a)^2})(1 + 0.275 f_{clu})$$